(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 475 295 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
10.11.2004 Bulletin 2004/46

(51) Int Cl.[7]: **B62D 29/00**

(21) Application number: **04076373.2**

(22) Date of filing: **07.05.2004**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IT LI LU MC NL PL PT RO SE SI SK TR
Designated Extension States:
AL HR LT LV MK

(30) Priority: **08.05.2003 GB 0310524**

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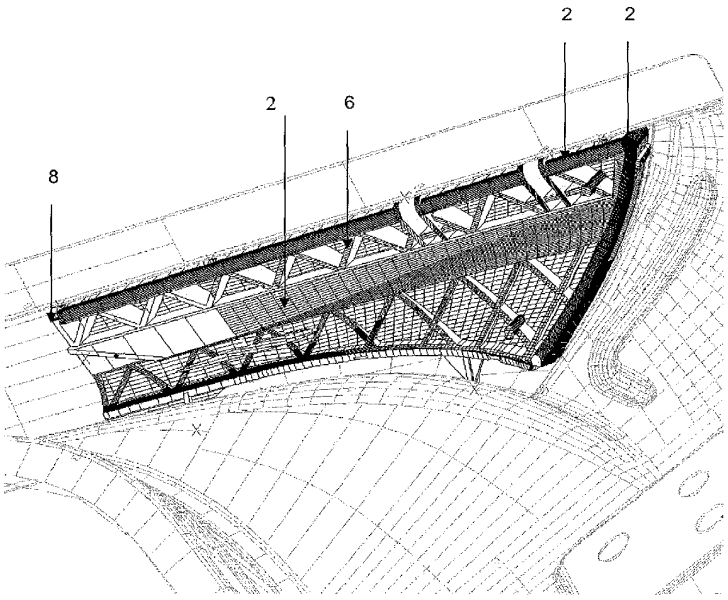
(54) Improved reinforcing members

(57) A structural reinforcement for a hollow section at least part of at least one of whose surfaces is the internal surface of an external panel comprising a rigid reinforcing member having a shape that substantially conforms to the cross section to be reinforced. An expandable adhesive material is provided over a portion of the surface of the rigid reinforcing member and the shape of the rigid reinforcing member and the amount and location of the expandable adhesive is such that upon foaming the foam contacts and bonds to the internal surfaces of the hollow section other than the interior surface of the external panel. In this way deformation of the external body panel during the foaming and/or cooling of the foamed expandable material is reduced or prevented.

FIGURE 4



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Description

[0001] The present invention relates to reinforcing materials and in particular to reinforcing materials that can be provided in hollow cross-sectional members particularly to provide reinforcement to improve the structural integrity of vehicles. The invention is particularly concerned with structural reinforcing materials that abut against the internal surface of external panels of the vehicle where the aesthetic appearance of the outer surface of the panel is important.

[0002] Structural reinforcement can be provided by the provision of a reinforcing member within a hollow structure such as part of an automotive frame. It is known that the reinforcing member may comprise a core, typically a hollow core of metal or rigid plastic, carrying a structural adhesive foam. In the known processes the foam is expanded when heated to bridge the small gap between the core and the hollow structure so that the core is bonded to the hollow structure. Typically the nature of the structural adhesive foam is chosen so that it expands at the temperatures used to bake the coating that is applied to the hollow structure during the e-coat anti-corrosion coating technique widely used in the automobile industry.

[0003] It has not however been possible to apply these techniques to provide satisfactory reinforcement to those areas of an automobile where the reinforcement is to be provided behind the internal surface adjacent to external panels of the vehicle. This problem, sometimes known as read through, has arisen because the foam tends to shrink as it cools after foaming which can cause unsightly deformation of the external panels of the vehicle which tend to be made of thin flexible sheet metal.

[0004] The present invention overcomes these problems.

[0005] The invention therefore provides a system whereby reinforcement can be provided to external panels of automobiles without causing deformation of the external surface of the external panel.

[0006] European Patent 1256512 addresses this problem and provides a cap to cover the foam in the areas that it contacts the outer panels. This cap is however expensive and can make the production and assembly of the part complicated.

[0007] The trends in motor vehicle design are towards lighter vehicles to improve fuel consumption. At the same time the safety standards and requirements are becoming more rigorous as indicated by the European Union requirements and the Euro-NCAP impact testing. The use of lighter materials such as aluminum to produce the hollow cross-sectional members that are used as vehicle sub frames has lead to the need for additional reinforcement. There is also a need for reinforcement behind external panels in various locations in the vehicle such as in window and door surrounds particularly in cavities between window and door frames and external panels such as in the reinforcement of hatchback doors and windscreen pillars where they connect with the roof of the vehicle.

[0008] There are four main types of application where structural reinforcement is required in vehicles. Crash protection where the prevention of vehicle body deformation is important to provide protection for the occupants. Energy absorption to enhance performance after yield. The reduction of flexing or body movement in the vehicle structure particularly to improve durability and reduce stress cracking and the point mobility problems requiring the reduction of resonance by the provision of stiffening. The need for reinforcement is present irrespective of the materials that are used to produce the vehicle structure and the need varies from material to material according to the nature of the reinforcement that is being provided. The reinforcing parts can also reduce the noise created by the motion of a vehicle by having a sound deadening effect as a result of blocking air paths in cavities.

[0009] It is known to provide longitudinal reinforcing structures within the hollow cross sections of vehicles. For example, PCT Publication WO97/43501 provides a beam, which can be mounted within the cross section to provide reinforcement along one axis in a hollow structure. The beam is provided with an expandable adhesive on two surfaces, which can be foamed upon heating to bond the beam to two opposed walls of the cross section. This technique is not suitable for use in the electrocoat process. Furthermore, the beam will only provide significant reinforcement along the axis of the beam. In WO97/43501 the beam with foamable material on opposed surfaces is placed in the cavity and subsequently foamed under the action of heat. This will result in uneven foaming and to non-uniform foam structures since on the underside the foam must raise the weight of the beam whereas expansion on the topside is free.

[0010] It is also known to provide foamable plastic mouldings within the hollow cross sections, these mouldings can be foamed upon application of heat, such as is provided by the baking step in the electrocoat process, to provide a foamed baffle that fills the cross-section to provide sound adsorption. Such systems are described in European patent applications 0383498 and 0611778. The foam baffle provides sound deadening and vibration resistance. In these systems the entire insert is foamable and it is proposed that the foamable material be chosen so that it will foam during the baking process, which follows the electrocoat process typically used in vehicle manufacture to provide resistance to metal corrosion. The materials of these patents are not however reinforcing materials but are used to provide acoustic baffles and seals.

[0011] In the electrocoat process a vehicle structure is immersed in a bath of coating fluid from which an anticorrosion coating is deposited on the metal by electrolysis. The vehicle metal structure is subsequently heated to bake the coating on the metal. The electrocoat proc-

ess is typically applied to complete vehicle structures in which hollow sections have been capped. Accordingly reinforcing structures are preferably provided within hollow sections prior to the electrocoat. It is therefore important that the reinforcing structure have minimal impact on the operation and efficiency of the electrocoat process.

[0012] A problem associated with both the reinforcing materials and the baffles is that if they are provided to produce foam adjacent to an external metal panel the shrinkage of the foam as it cools after expansion can cause undesirable deformation of the metal panel leading to imperfections in the outer surface of the vehicle.

[0013] There is therefore a need to provide structural reinforcement for the hollow cross-sections of vehicles, which is easily supplied, works well within the bounds of the electrocoat process, provides effective reinforcement to the vehicle both during operation and as crash protection and does not cause deformation of the external body panels of the vehicle during its manufacture.

[0014] The present invention therefore provides a structural reinforcement for a hollow section part of at least one of whose surfaces is an external panel comprising a rigid reinforcing member having a shape that substantially conforms to the cross section to be reinforced with an expandable adhesive material over a portion of the surface of said rigid reinforcing member wherein the combination of the shape of the rigid reinforcing and the location, size and shape of the expandable adhesive material is such that the material expands but does not contact the part of the surface that is an external panel.

[0015] In this way deformation of the external body panel during the foaming and/or cooling of the foamed expandable material is reduced or prevented.

[0016] The dimensions of the rigid reinforcing member and the thickness, location and nature of the expandable material are critical to the achievement of the desired structural reinforcement and to prevent deformation of the external body panel. The exterior shape of the reinforcing member should conform substantially to the cross section of the section of the structure it is designed to reinforce but it should be shaped so that the foam does not bear against the interior surface of the external body panel in a manner that will cause deformation of the panel. The shape of the reinforcing member may vary along its length as the dimensions of the cross section of the structure change. The size of the reinforcing member including the expandable adhesive material should be such that there is a small clearance between the extremity of the reinforcing member and the interior walls of the structure to be reinforced to allow for passage of the electrocoat fluid. Furthermore the reinforcing member should be shaped so that on expansion of the foam, the foam does not contact the entire interior surface of the external panel that forms part of the walls of the hollow structure. The foam should however contact and bond to other surfaces of the hollow structure so that the rigid reinforcing member is held firmly within the structure. The reinforcing member may have a cellular, honeycomb or ribbed internal structure to provide reinforcement along several different axes.

[0017] One or more of the walls of the hollow section that is reinforced according to the present invention may be entirely of the external panel. Similarly part of one or more walls of the hollow section may be provided by an internal structural member and another part of the walls of the hollow section may be provided by an external panel. Generally only one of the walls defining the hollow section is an external panel and it maybe that only part of one of the walls is an external panel. Accordingly in these circumstances the reinforcement may be provided according to the present invention by the expandable adhesive foam expanding and adhering to that part of the structural member which is not an external panel and not contacting and adhering to the part of the member that constitutes the external panel. In this instance reinforcement can be provided to the external panel by virtue of the proximity of the foam and/or the core of the structural reinforcing member to the external panel. This may be achieved by the appropriate distribution of the expandable adhesive material over the surface of the core and the provision of the appropriate amount of foamable material. The optimum distribution and amount of expandable material will depend upon the size and shape of the hollow section.

[0018] The structural reinforcing member needs to be located within the hollow section to be reinforced in a manner that enables satisfactory performance of the e-coat process without undesirable movement of the structural reinforcing member. Various means of attachment can be provided for example means such as clips may be molded in the core which can be clipped into holes formed in the walls of the hollow section other than the wall or walls which constitute the external panel. Similarly attachment means such as clips may be formed in the walls of the hollow section, other than the external panel, which can fit into holes in the core of the reinforcing member. Alternatively or additionally the structural reinforcing member may be provided with small lugs, which enable it to stand away from the interior walls of the hollow structure. In this way fastening devices may not be required and the area of contact between the structural reinforcing member and the interior walls of the frame of the vehicle is minimized. The lugs should not however contact the wall of the hollow structure that constitute the inner surface of the external panel.

[0019] The clearance between the extremity of the reinforcing member and the interior walls of the hollow section should be wide enough to enable the liquid used in the electrocoat bath to flow between the reinforcing member and the interior walls of the sections of the vehicle in sufficient quantity to enable an effective anti-corrosion coating to be deposited. On the other hand, the clearance must not be too wide since this can result in

a lack of rigidity in the structure when the expandable adhesive is foamed to bond the structural reinforcing member to the walls of the hollow section other than the external panel. We prefer that the clearance be no more than 1 centimeter and is more preferably 3 to 10 millimeters. The clearance around the whole structure enables a more uniform foam structure to be obtained.

[0020] The rigid reinforcing member may be made from any suitable material, for example it may be made of metal or plastic and the material will be chosen according to the preferred fabrication method. This in turn is driven by economics and the complexity of the cross section to be reinforced. Reinforcing members for simple cross sections may be prepared by extrusion whilst injection moulding may be required for more complex structures. Metal members may be produced by stamping and/or forming. Where extrusion is used the members may be of metal or thermoplastics; where injection moulding is used thermoplastics are preferred. Polyamides, particularly glass filled polyamides are suitable materials due to their high strength to weight ratio. Alternatively injection moulding or die casting of metal alloys may be employed. It is preferred that the moulding is provided with means enabling fluid drainage. For example, holes may be provided in the moulding to allow the drainage of water, which may condense in the structure over time.

[0021] The preferred shape and structure of the reinforcing member will depend upon where it is to be located in the vehicle structure and the function it is to perform. The present invention is particularly useful in the reinforcement of areas around doors and windows and especially for the reinforcement of hatchbacks and particularly the upper extremity of a hatchback which is attached to the upper portion of the vehicle structure. It is also useful in the reinforcement of windscreen frames where they join with the roof of the vehicle which may be the external panel.

[0022] The expandable adhesive material serves two main functions, it will expand across the space between the reinforcing member and the interior of the hollow section without touching the inner surface of the exterior panel, the material will also bond to some or all of the interior walls of the hollow structure which do not constitute an external panel. Accordingly, expandable adhesive material means that the material can be activated to both expand (typically foam) and to act as an adhesive. Activation therefore enables the expandable material to expand and fill a gap between the reinforcing member and a hollow structure it is designed to reinforce and to bond to selected internal surfaces of the hollow structure. Accordingly the expandable adhesive must expand at the desired temperature and be sufficiently adhesive to firmly bond the reinforcing member inside the vehicle structure. Once foamed it should be sufficiently strong that it does not contribute any weakness to the overall reinforcing effect provided. The distribution of the foamable material over the reinforcing core is such that on and after foaming it will not cause deformation of the external panel. This is achieved according to this invention by minimizing the amount of contact between the foam and the internal surface of the external panel, the area of contact is preferably zero. We have found that by careful control it is possible to provide reinforcement to an external panel whilst leaving a small gap between the internal surface of the external panel and the foam. This ensures that as the foam cools and shrinks the thin metal sheet of the external panel is not deformed by the contraction of the foam.

[0023] Prior to activation, the expandable adhesive material is preferably dry and not tacky to the touch, since this facilitates shipping and handling and prevents contamination. Examples of preferred foamable materials include foamable epoxy-base resins and examples of such materials are the products L5206, L5207, L5208 and L5209, which are commercially available from L & L Products of Romeo Michigan USA, and the Betacore Products 5204, 5206, 5205 and 5208 available from Core Products, Strasbourg, France. The product should be chosen according to the rate of expansion and foam densities required. It is further preferred that it expand at the temperatures experienced in the electrocoat baking oven, typically 130°C to 150°C.

[0024] The expandable adhesive material should be applied to at least a portion of the surface of the rigid reinforcing member that will be adjacent to an interior surface of the section of the vehicle frame that is to be reinforced whilst controlling the amount of foam adjacent to the external panel. It is preferred that the foamable material be applied over at least part of all the surfaces of the reinforcing member that are adjacent to the walls of the vehicle section and that the amount and location of foamable material applied over the surface of the reinforcing material adjacent to the internal surface of the external panel is controlled to prevent the foam causing deformation of the external panel. The optimum distribution will depend upon the shape of the section to be reinforced but the foam is preferably present so that it provides adhesion to two non-parallel surfaces to give rigidity in at least two dimensions. The expandable material may be applied to the rigid reinforcing member by bonding a strip of the material to the member, by extrusion coating or by injection moulding. Where the reinforcing member is made by injection moulding the expandable material may be applied by over-moulding or two shot injection moulding. The material should however be applied under conditions such that no foaming takes place.

[0025] The thickness of the expandable adhesive material and the degree of expansion must be controlled so that upon expansion the foam fills the space between the rigid reinforcing member and the hollow profile but the foam does not contact the internal surface of the external body panel to the extent that cooling of the expanded foam deforms the external body panel. This may be accomplished by providing no expandable material

on the surface of the structural reinforcing material that is adjacent to the internal surface of the exterior panel or controlling the amount and thickness of the expandable material at the surface of the structural reinforcing material adjacent to the exterior panel so that, upon expansion, it is in close proximity to but touches no more than 50% of the area of interior face of the exterior panel and preferably does not touch the interior face of the exterior panel.

[0026] The hollow section with the reinforcing member in place may then be subjected to the electrocoat process in which it is passed through a bath of coating material and a corrosion resistant coating is deposited onto the structure by electrolysis. The vehicle structure is then dried in an oven to provide the final coating and the expandable adhesive is preferably chosen so that it is activated by the drying conditions used in the oven employed to bake the coating on the electrocoat process. In this way the expandable material will expand under the drying conditions to provide a foam that fills the space between the member and the interior walls and will produce a strong bond between the reinforcing member and the interior wall. Typically the coated structure is dried at around 165°C for about 20 minutes and accordingly the adhesive should expand under these conditions. The industry is however looking to use lower drying temperatures and shorter drying times and this may influence the choice of expandable adhesive materials.

[0027] If other components for example bolts are to pass through the reinforcing members during subsequent assembly care must be taken to ensure that holes formed in the reinforcing member for the passage of the bolts are not blocked by the foam as it expands.

[0028] The techniques of the present invention may be used for the reinforcement of any construction that is based on a hollow frame structure in which at least part of one or more walls is an external panel. The techniques may for instance be used in the construction industry, in boats, in aircraft, and in railroad applications. They are however particularly useful to provide reinforcement in automobiles including cars, trucks, caravans and the like. The techniques are particularly useful in the current trend towards using lighter and sometimes weaker materials in the production of automobile sub frames where there is a greater need for reinforcement to compensate for the reduction in strength of the basic material and yet satisfy the safety requirements. This is particularly the case with the use of aluminum for the production of automobiles.

[0029] The present invention is illustrated by reference to the accompanying drawing which shows a structural reinforcement for use in providing reinforcement to vehicle windscreen pillars and their interaction with roof panels.

[0030] Figure 1 shows a part comprising a core of moulded glass filled nylon (1) coated in most areas with a foamable material (2). The core is also provided with protrusions (3) whereby the part may be clipped into the wall of the hollow structure it is to reinforce. Small protrusions (4) are also formed in the frameable material which act as spaces between the core and the hollow structure to allow passage of the e-coat fluid. As is illustrated no foamable material is provided at the position (5) on the core which will lie against the inner surface of the external roof panel of the automobile when the part is in place. Ribs (6) are provided as part of the core (1) to provide additional reinforcement.

[0031] Figure 2 is a view of the reverse side of the part shown in Figure 1 showing how foamable material is provided along the sides of the core (7) and at one of the end (8) and a strip of foamable material (9) is provided down the inner surface of the core moulding.

[0032] Figure 3 shows how the part (1) inserted in the windscreen support of a vehicle and Figure 4 is an expanded view from the outside of the vehicle of the part installed according to Figure 3 with the external panel (1) removed showing how the foamable material is separated from the internal surface of the external panel.

Claims

1. A structural reinforcement for a hollow section of at least one of whose surfaces is an external panel of a vehicle comprising a rigid reinforcing member having a shape that substantially conforms to the cross section of the hollow section to be reinforced with an expandable adhesive material over a portion of the surface of said rigid reinforcing member wherein the shape of the rigid reinforcing member and the amount and distribution of the expandable adhesive are such that upon expansion the adhesive material does not contact the inner surface of the external panel and contacts and adheres to at least part of the other inner walls of the hollow section.

2. A structural reinforcement according to Claim 1 in which the exterior shape of the reinforcing member conforms substantially to the cross section of the section of the structure it is designed to reinforce.

3. A structural reinforcement according to Claim 1 or Claim 2 in which the size of the reinforcing member including the expandable adhesive material is such that there is a small clearance between the extremity of the reinforcing member and the interior walls of the structure to be reinforced to allow for passage of the electrocoat fluid.

4. A structural reinforcement according to any of the preceding Claims in which one or more of the walls of the hollow section that is reinforced according to the present invention is composed entirely of the inner surface of an external panel.

5. A structural reinforcement according to any of Claims 1 to 3 in which part of one or more of the walls of the hollow section is provided by the internal surface of an external panel.

6. A structural reinforcement according to any of the preceding Claims in which the reinforcing member is adhered to the hollow structural member by the expandable adhesive foam expanding and adhering to internal surfaces of the structural member but not adhering to the internal surface of the external panel.

7. A structural reinforcement according to any of the preceding Claims in which the reinforcement is provided to the external panel by virtue of the proximity of the foam and/or the core of the structural reinforcing member to the internal surface of the external panel.

8. A structural reinforcement according to any of the preceding Claims in which the rigid reinforcing member is made of metal or plastic.

9. A structural reinforcement according to any of the preceding Claims in which no expandable material is provided on the surface of the structural reinforcing material that is adjacent to the interior surface of the external panel.

10. The use of a structural reinforcing material according to any of the preceding Claims for the reinforcement of frames around vehicle doors and windows.

11. The use according to Claim 10 for the reinforcement of the upper extremity of a hatchback door where it is attached to the upper portion of the vehicle structure.

FIGURE 1

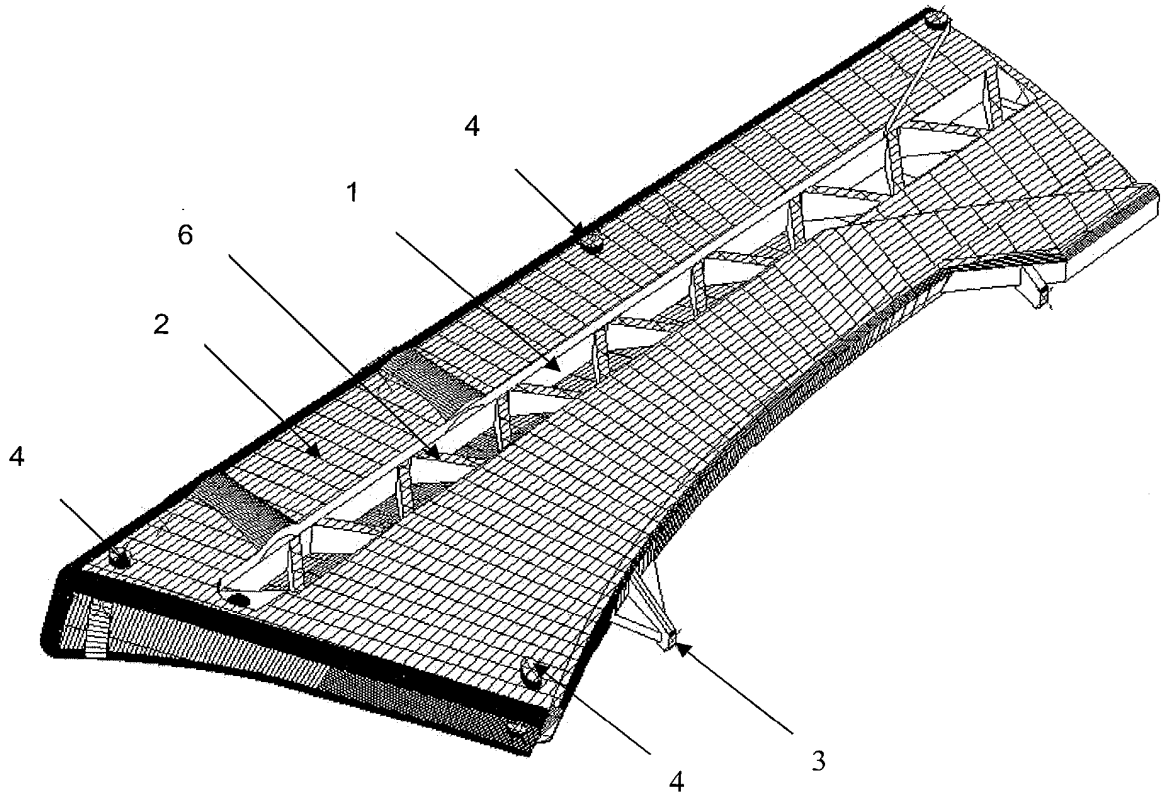

FIGURE 2

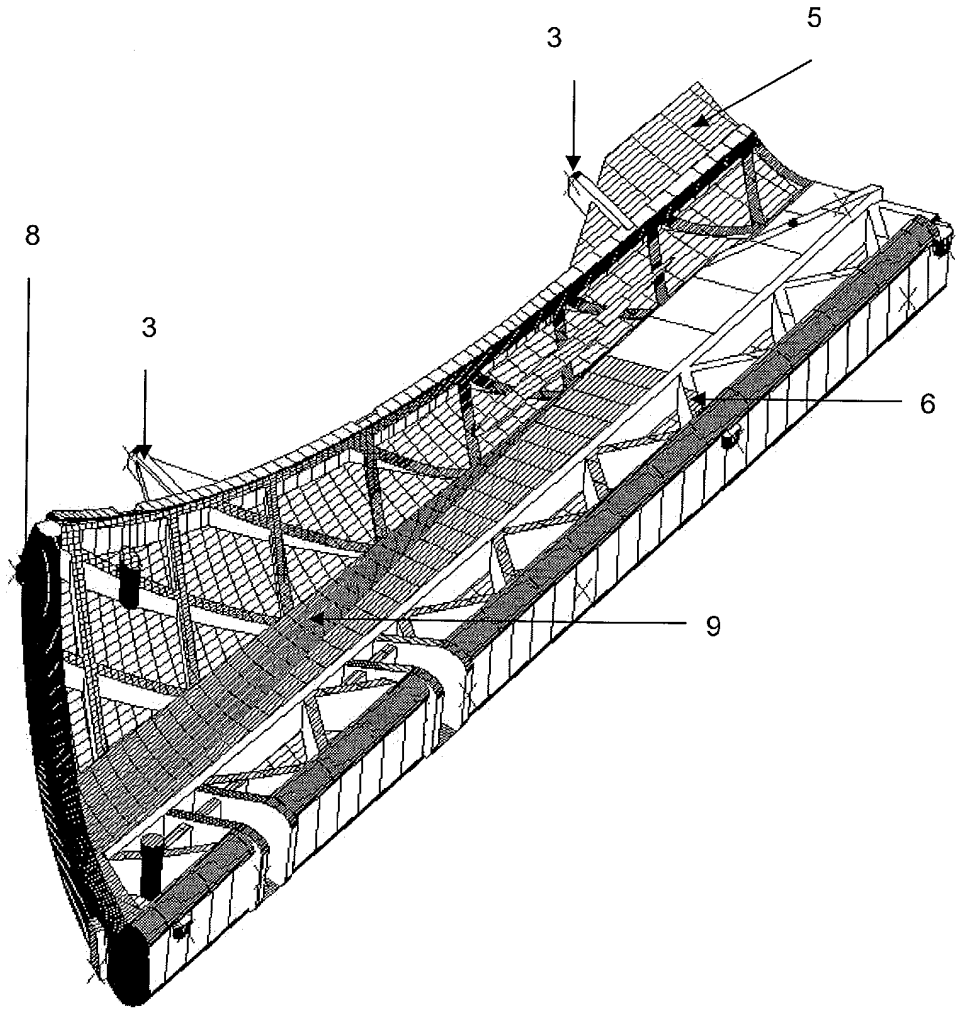

FIGURE 3

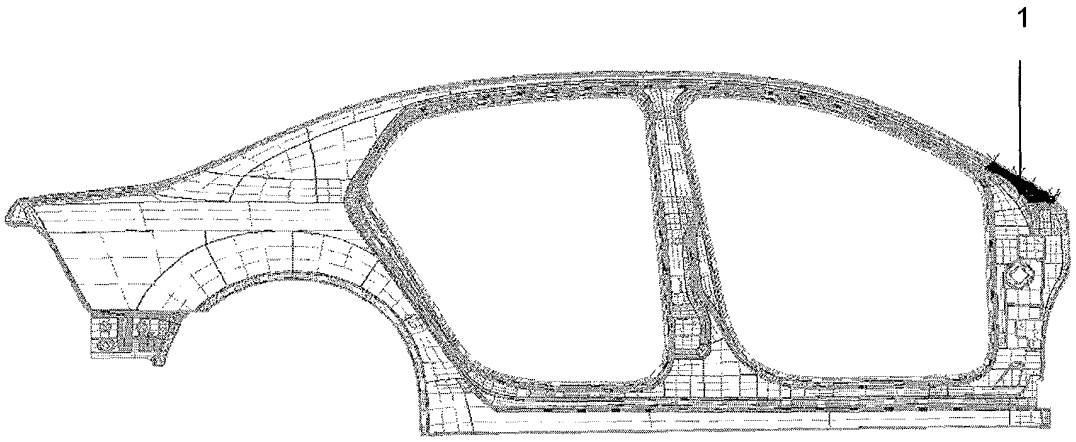

FIGURE 4